Proposal to the
National Aeronautics and Space Administration
from
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A New Fast Response Photofragment Fluorescence Hygrometer for Use on the Perseus Unmanned Aircraft

Final Technical Report

NASA Agreement NCC-2-898

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Under NASA Agreement NCC-2-898 we proposed to adapt the photofragment fluorescence hygrometer which had successfully flown on the ER-2 for use on the Perseus unmanned aircraft. When this proposal was submitted, it was our understanding that we would not continue to fly our 3" water vapor instrument on the ER-2 and that it would, therefore, be a suitable starting point for the 2" Perseus system. However, the emergence of the STRAT program and the plan to include our instrument as the sole water vapor experiment on the ER-2 prevented us from following through with the plan as outlined in the proposal.

Objectives: Water vapor plays a critical role not only as a tracer of stratospheric air from the tropics to midlatitudes (and vice versa) but is unique in its providing the signature of its temporal history as it crosses the tropical tropopause. As such, its inclusion as part of a tracer payload on an unmanned aircraft is absolutely necessary. Such a payload is planned specifically to provide extensive high resolution tracer data up to 27 km, well above the range of the ER-2, in a region where as yet no in situ tracer data is available. While tracer-tracer relations at these altitudes have been provided by remote instrumentation from the Space Shuttle the investigation of the barrier to transport between the tropics and midlatitudes requires high resolution in situ data.

Principle of operation: The instrument uses the principle of photofragment fluorescence along with absorption to measure the mixing ratio of water vapor from concentrations of about $1e^{13}$ molecules /cc in the stratosphere to $5e^{16}$ molecules/cc in the mid-troposphere. Water vapor in the central core of ambient air, ram-fed through a 2" square duct, is excited by Lyman-α radiation emitted by an rf-excited low pressure hydrogen discharge lamp. The fluorescence emitted by the excited OH fragment is focused through a bandpass filter center at 310 nm and detected by a PMT at right angles to the exciting radiation and flow. This instrument has been designed to measure water vapor in the lower stratosphere and upper troposphere with an accuracy of better than 10% and a precision of better than 5% per 4 second data point. The instrument as designed, including ducting, valves, computer, and insulation was projected to weigh about 35 kilograms, and draw about 250 watts.

Summary of progress:

Before the decision was made to continue flying the ER-2 instrument, we designed and fabricated much of the flow tube and duct parts necessary to build a separate water vapor instrument for Perseus, with the duct dimensions similar to the Perseus ClO instrument. Additionally, gas deck parts, valves, and pressure sensors have been purchased, and the flight computer built and tested. Many parts were also purchased to update the computer control of the water vapor calibration bench. Using backup mechanical and electrical

components from the ER-2 instrument, as well as some additionally designed and fabricated detection axis parts, we have assembled and completed a preliminary test of sensitivity and lamp scatter for a 2 inch water vapor detection axis. These preliminary numbers are promising and consistent with those from the ER-2 (3 inch cross section) instrument.